NEW PRODUCT

3500 TSI Valve Position

Now part of the 3500/45 Position Monitor

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Turbine Supervisory Instrumentation (TSI) Systems continuously monitor a wide variety of steam turbine generator operating parameters. The TSI system provides monitoring, diagnostic, and predictive maintenance information necessary for protecting and managing turbine generators and other critical machinery. Now, Bently Nevada's advanced 3500 Machinery Protection System has been expanded to include valve position measurement.

Steam turbines vary in design, but, generally, the steam enters the turbine through the main stop/throttle valves and flows to one or more governor valves. The governor valves control the flow of steam into the high-pressure (HP) turbine section. Additionally, after reheat, the steam enters the intermediate pressure (IP) turbine through the reheat stop-intercept valves.

Valve position is varied to maintain or change the load. In a steam turbine, the various possible modes of changing load in megawatts (MW) are:

1. "Single-valve" mode, where a group of governor valves open or close in unison to change the valve flow passage area.
2. "Sequential-valve" mode, where multiple governor valves are sequenced to open or close in a predetermined order at either constant or changing inlet throttle steam conditions.
3. "Sliding pressure" mode, where a group of governor valves are fully open or maintained at a constant partially open position while inlet throttle pressure is changed to vary the flow through the turbine.

In the "single-valve" mode, all the governor valves operate in unison to vary the steam flow to the turbine inlet bowl by changing the amount of valve opening. Large turbines may have a full 360° arc of admission, while smaller units may have a fixed percentage partial arc admission. In the "sequential-valve" mode, the governor valves, as they open and close in sequence, feed steam to the blading through a changing circumferential admission arc. The size of the arc passing steam can be expressed as a percent of full arc admission. In the "sliding pressure" mode, the governor valves remain at a fixed opening and feed steam through a constant arc or percent of admission.

Turbine-generator hold points (for thermal soaking), acceleration-to-rated-speed, synchronization, and loading can be accomplished with flow controlled by either stop valves or the governor valves, using full arc or partial arc admission, or by changing the inlet throttle pressure.

In addition to stop valves and governor valves, there are also reheat stop valves and intercept valves located in the lines between the reheater and the IP turbine. The function of these valves is to protect the turbine against overspeed from stored steam in the boiler reheater section and sometimes to provide additional control function if the valves have been designed accordingly.

Advantages of the 3500 Position Monitor

The 3500 Position Monitor displays the position of a valve as % open or % closed of its full motion. The measurement can be based on linear or rotary motion. Linear motion relates to movement of the valve stem, while rotary motion relates to movement of the cam shaft.

AC LVDTs (Linear Variable

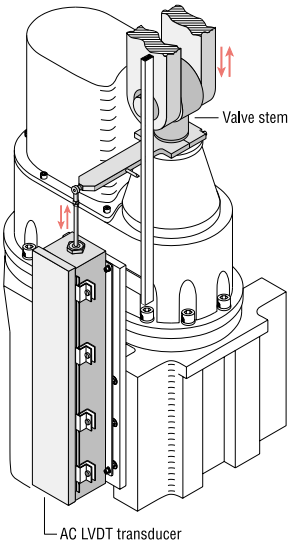

Figure 1. Typical AC LVDT installation on a valve stem.

Differential Transformers) are the transducers of choice for measuring the position of a valve stem, based on the valve's full stroke length (Figure 1). Their only electrical components are coil windings, allowing them to be used in environments up to 149° C (300° F). They are sealed fairly well against contaminants and have good accuracy.

The 3500/45 Position Monitor drives the primary winding of the LVDT with an ac signal. It conditions the signals that appear on the two secondary windings and combines them to give an indication of linear position. The 3500/45 does this without requiring any intermediate components or converters. The position measurement will be displayed as % open or % closed, as configured by the user. The available full scale ranges are:

1 in (25mm)	2 in (51mm)
4 in (101mm)	6 in (152mm)
8 in (203mm)	10 in (254mm)
12 in (305mm)	20 in (508mm)

A rotary potentiometer is used to measure the rotational position of a camshaft, which controls the sequencing of several valves. There are different full-scale ranges of rotation, depending on the steam turbine's design. The 3500/45 Position Monitor now offers full-scale ranges from 50° to 300° of rotation, displayed in % open or % closed, as configured by the user.

The new 3500/45 Position Monitor provides four channels of valve position using either four AC LVDTs or four rotary potentiometers. Another highlight of the 3500/45 Position Monitor is the option to use an AC LVDT to obtain a case expansion measurement when the operating environment of the case expansion transducer is above 85° C (185° F), preventing the use of the DC LVDT.

Average valve position measurement is ambiguous

In addition to needing to know the position of various individual steam valves, some customers have requested an average valve position measurement. They average the governor valve % openings to give an overall % of effective steam flow, which is related to load. This is really an average only if the mode of operation is "single valve" (all governor valves opening in unison) or if the mode is sequential and there is a linear relationship between the position of each valve and the overall percentage of flow.

However, the sequential mode relationship generally is not linear, thus the operator still must interpret the meaning of the average with respect to the steam flow. Even if the relationship between sequential valve opening and effective steam flow was linear or the mode of operation was single valve, knowing the average would not necessarily be that valuable. If a faulty valve is not opening when it should, the turbine control system opens the remaining governor valves to maintain the load. The average would still read the same as if the faulty valve were operating correctly. You would not know that there was a problem with the valve until other, more serious, problems presented themselves, such as unbalance of casing temperatures, casing distortion, increased thermal fatigue damage, or even a rub condition. Therefore, each individual valve opening should be known, not just an average or effective steam flow.

Correlating each valve's position to load is more meaningful

Comparing valve position to load over time will provide an indication of changing turbine efficiency or machine problems. Specifically, equating an individual valve's position to load is more valuable than averaging the valve positions, especially when operating in the sequential valve mode. With the new 3500/45 Position Monitor options for valve position and with the new System 1 machine management software (see article, page 33), you will be able to set alarms for each valve's position based on its relationship to load. The load measurement could be obtained using a 3500 Process Variable Monitor.

For example, Figure 2 shows the opening sequence of the eight governor valves displayed in % open for each valve versus the % of full load of the unit. Based on the data, you could set software "under alarms" for governor valves 1 to 4, 5, and 6, based on the % of full load (MW). The logic that could be incorporated might be: If the load is greater than 90% of full load and governor valves 1 to 4, 5, or 6 are less than 98% open, then alarm. Thus, the operator would be forced to acknowledge the

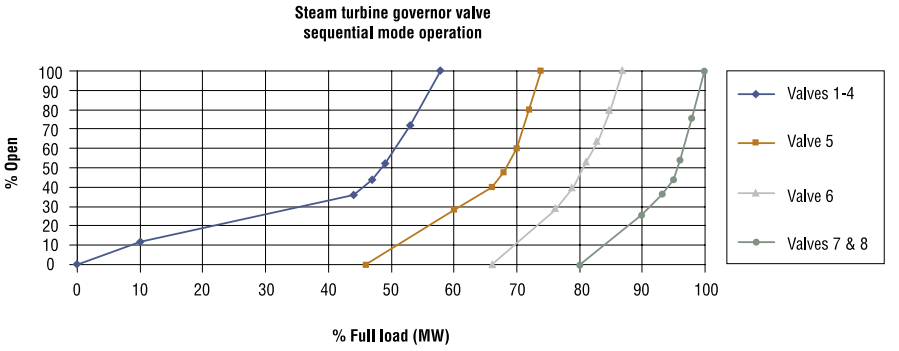

Figure 2. Opening sequence of governor valves versus load.

condition where a valve is not in its correct position for a particular steady state load and operating mode.

Correlating valve position to vibration

Correlating valve position to vibration response can also be very useful, particularly on partial arc admission turbines. Depending on the sequence of valve openings, steam nozzle forces can lift the rotor within the bearing. This can lead to a fluid-induced instability if the centerline position of the rotor is near or equal to the geometric center of the bearing. Rotors operating at low eccentricity ratios also reduce the available bearing stiffness properties. This will cause higher levels of vibration with no change in the balance state of the turbine. You can use the correlation between opening valves, shaft centerline position, and vibration levels to adjust the valve opening sequence for more stable machine operation.

Conclusions

Valve position is a parameter that provides information about the turbine during all phases of its operation: start-up, running, and shutdown. Valve position is related to the amount of turbine load while the generator is on-line; it is varied to maintain or change the load. Our 3500 Machinery Protection System can now provide the valve position measurement to our machinery management system to correlate with other machine critical measurements, such as load, temperature, pressure, or vibration. This can be useful in determining overall turbine efficiency and in identifying machine problems.

Announcements

Bently Nevada receives award from General Electric for excellent global support

Bently Nevada was one of only 180 vendors invited to the General Electric Power Systems Global Supplier Conference held in Atlanta, Georgia, 18-19 January 1999. As GE put it, “As one of our key suppliers, you have been invited to share in a two-day discussion of our changing market conditions and our new global sourcing strategy. A highlight for us on Monday is our awards banquet, where we will honor suppliers from across our GE businesses.”

Five awards, one from each of the major GE divisions within Power Systems, were given to the companies with the most improved “Six Sigma scorecards.” Six Sigma is the cornerstone of General Electric's long-term operating strategy. It is fundamentally a quality improvement program, but it also embraces delivery timeliness, cost reduction, and effective integration of the supplier with GE. The last award given that night, which we consider the most prestigious award, was to the company doing the best job working with all of the GE Power Generation business units worldwide. John Campi, GE's Sourcing Council Leader, presented the award for “Broadest Supplier Involvement” to Bently Nevada Corporation.

While Bently Nevada has received numerous accolades from customers over the years, virtually all of them have been for recognition of product quality, our quality management system, delivery timeliness, etc. In short, we have been frequently honored for the excellence of what we do in the factory. This award, by contrast, was a recognition of the excellence and the value of our global Sales and Service organization. We are proud to have received it, and are grateful to GE for the honor.